BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS:IMSc **SEMESTER : VIII**
BRANCH: Food Tech. **SESSION : SP/22**

SUBJECT: FT421 AUTOMATION IN FOOD PROCESSING INDUSTRY

TIME: 2 PM - 4 PM **FULL MARKS: 50**

INSTRUCTIONS:
1. The missing data, if any, may be assumed suitably.
2. Before attempting the question paper, be sure that you have got the correct question paper.

Attempt any 7 from Q.1-Q.9 2×7

Q.1 Define different types of accuracy for a temperature sensor with examples. [2]
Q.2 Explain the operating principle of an electronic-type level transducer. [2]
Q.3 What is reference voltage of a thermocouple? Define sensitivity of thermocouple. [2]
Q.4 How an ultrasonic flowmeter measures the velocity of a moving object in liquid flow? [2]
Q.5 Name different types of control valve in a process industry? What is actuator in process control? [2]
Q.6 Explain the importance of enzyme measurement in food process. [2]
Q.7 Locate different components of a pH meter with a diagram. [2]
Q.8 Briefly depict the uses of a refractometer in food process control. [2]
Q.9 In a rotating cylinder viscometer, the inner cylinder of radius 0.02 m and length 0.06 m is rotated at 2 Hz (rotation per second) in a syrup that generates the torque of 5×10^{-4} Kg m^2 s^{-2}. Estimate the viscosity of the syrup. [2]

Attempt any 5 from Q.10-Q.17 2×5

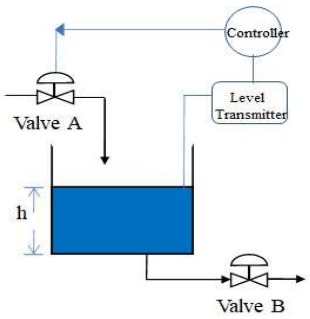
Q.10 Write down the advantages and disadvantages of feedback and feedforward control systems? [2]
Q.11 What are the differences between P-I and P-I-D controller? [2]
Q.12 Compare between Pneumatic and Hydraulic control systems. [2]
Q.13 What are the components of system for food quality quantization & process control? [2]
Q.14 What are the basic aspects of robotics? [2]
Q.15 What are the various types of sensors used in robotics? [2]
Q.16 Define the microcontroller and state the use of microcontroller in robotics. [2]
Q.17 What are the essential steps in computer vision system application for automation of food processing? [2]

Attempt any 2 from Q.18-Q.20 3×2

Q.18 Depict the mechanism of a strain gauge pressure transducer with a diagram.
Q.19 Explain operation of an optical absorption type turbidity meter with a diagram.
Q.20 Briefly explain a statistical model-based control scheme in a food process.

Attempt any 2 from Q.21-Q.23 7.5×2

Q.21 a) Figure depicts the liquid level control system using proportional controller. Valve A is linear with a flow scale factor of 10 m^3/hr per % controller output is nominally 50 % with K_p = 10 % per %. A load change occurs when the flow through valve B changes from 500 m^3/hr to 550 m^3/hr. Set point is at 6 m and the liquid level can vary from 1–13 m. Calculate the new level upon load change. [4] [7.5]

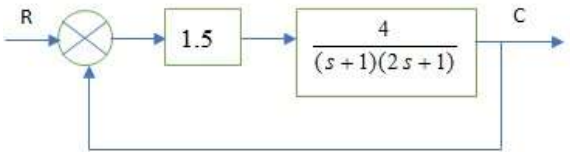


b) A proportional controller is used to control the height of water in a tank where the water level can vary from 0–9 m. Calculate the value of PB and K_p that will set the water level at a desired height of 5.0 m. The controller is required to fully close the inlet valve A when the water level rises to 5.5 m and fully open the inlet valve A when the water level falls down to 4.5 m. [3.5]

Q.22 a) A PI controller is used to control the pressure in a tank which varies from 40 psi to 140 psi. Desired pressure is 90 psi. Controller output is to change by 100% upon 40 psi pressure deviation. Reset rate is 1/5 repeats per min and controller output at zero error is 50 %. Calculate the controller output at the end of 2 min, when pressure in the tank becomes 80 psi. [4] [7.5]

b) A process control loop has Gc as PI controller. Process is an integrating element with a process gain of K. Control valve and measuring element have unity transfer function. Find the relationship among K, K_p and K_i for a damping factor of 0.5. [3.5]

Q.23 a) The set point in the loop shown in figure is given a step change of magnitude 5 units. Determine the maximum value of C and the time at which it occurs, the offset and period of oscillation. [4] [7.5]



b) A control loop is setup with element $\frac{1}{(s^2+0.5s+1)}$, and a proportional controller with unity feedback. What should the value of Kc be so that the response exhibits a quarter decay? [3.5]

5×1

Attempt any 1 from Q.24-Q.25

Q.24 Construct a block diagram of the computer control loop in a specific food processing. Locate the various components for measurements, signal transmissions, interfacing, and process control. [5]

Q.25 Consider a CSTR with 1st order irreversible and isothermal reaction $A \rightarrow B$ of reaction rate $-r_A = 0.1C_A$. Here $C_A$is the composition of A in the reactor. The volume of the reactor, V is 2 m^3, steady state volumetric flow rate of reactant feed solution, F is 0.02 m^3/s, and inlet feed composition, C_A^{in} is 0.1 mol/m^3. The composition balance in the reactor is given by: [5]

$$\frac{dC_A}{dt} = \left(\frac{F}{V}\right) C_A^{in} - \left(\frac{F}{V}\right) C_A - 0.1C_A$$

a) Determine process transfer function relating composition C_A and inlet feed composition C_A^{in}.

b) Construct the feedback loop for composition control locating manipulated variable (input), measured variable, and disturbance (input).

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